

# Technology Readiness & Transition

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**Technologist develops a new technology**

**It “sits on a shelf” somewhere.**

**No one uses it.**

# Background Definitions

- *Technology:*
  - Includes product technology and process technology
- *Technology readiness:*
  - means readiness for successful use in company business practices, especially on airplane programs, and usually by people other than the developers of technology
- *Technology transfer:*
  - means transfer of the technology from the technology developers to the technology users

## *Situation:* **Technology Readiness & Transfer**

- *Root causes of difficulty in technology application include:*
  - Technology not developed to a suitable state of technology readiness
  - Inadequate assessment of technology readiness
- *Which result in:*
  - Missed opportunity for value-added application of technology
    - Technology not mature enough for use
    - Technology transfer unsuccessful
  - Commitment of immature technology to a program
    - Program schedule slides and cost overruns

# NASA Technology Readiness Levels (TRL)

TRL Number	Meaning
1	Basic principle observed and reported
2	Technology concept and/or application formatted
3	Analytical and experimental critical function and/or characteristic proof-of-concept
4	Component and/or breadboard validation in laboratory environment
5	Component and/or breadboard validation in relevant environment
6	System/Subsystem model or prototype demonstration in a relevant environment (ground or space)
7	System prototype demonstration
8	System prototype demonstration in a space environment
9	Actual system completed and "flight qualified" through test and demonstration (ground and flight)
10	Actual system "flight proven" through successful mission operations

Good so far as it goes, but does not address some critical technology barriers.

# Boeing Technology Maturity Stages

Maternity Stage	Discovery	Feasibility	Practicality		Applicability	
<b>Definition of requirements</b>	Awareness of a need	Understanding of key requirements	Detailed understanding of generic requirements	<b>Technology readiness</b>	Detailed understanding of application-specific requirements	<b>Application readiness</b>
<b>Technical work statement</b>	Exploration in laboratory environment	Initial development	Detailed development in real-world environment		Application-specific detailed development	
<b>Technical and application potential</b>	Technically plausible	Technically feasible, potentially practical	Technically solid with reasonable chance of applicability		Applicable and sufficient for the specific application	
<b>Business case</b>	Rough	More detail	Sufficient for decisions		Part of business plan	
<b>Participants</b>	Principal technology developer	Key technical developers and technology users	All affected technical developers and all affected technology users		Technology users	
<b>Resource requirements for development</b>	Minimal	Appreciable	Very significant		Whatever it takes for specific application	
<b>Planning work statement</b>	Plan for feasibility stage	Plan for practicality stage	Plan for applicability stage		Plan for production implementation	

# Technology Development and Implementation

Transition Hurdle

Transition Hurdle

Maturity Stage		Discovery		Feasibility		Practicality		Applicability				Keep it Current and Maintain it
Definition of requirements	Awareness of a need		Understanding of key requirements		Detailed understanding of generic requirements		Technology readiness	Detailed understanding of application-specific requirements		Production readiness		
Technical work statement	Exploration in laboratory environment		Initial development		Detailed development in real-world environment			Application-specific detailed development				
Technical and application potential	Technically plausible		Technically feasible, potentially practical		Technically solid with reasonable chance of applicability			Applicable and sufficient for the specific application				
Business case	Rough		More detail		Sufficient for decisions			Part of business plan				
Participants	Principal technology developer		Key technical developers and		All affected technical developers			Technology users				
Resource requirements for development	Minimal		Appreciable		Very significant			Whatever it takes for specific application				
Planning work statement	Plan for feasibility stage		Plan for practicality stage		Plan for applicability stage			Plan for production implementation				
		Basic principle observed and reported	Technology concept and/or application formatted	Analytical and experimental critical function and/or characteristic proof-of-concept	Component and/or breadboard validation in laboratory environment	Component and/or breadboard validation in relevant environment	System/Subsystem model or prototype demonstration in a relevant environment (ground or space)	System prototype demonstration	System prototype demonstration in a space environment	Actual system completed and "flight qualified" through test and demonstration (ground and flight)	Actual system "flight proven" through successful mission operations	NASA TRLs
		1	2	3	4	5	6	7	8	9	10	

**NASA  
TRLs**

# Typical Technology Readiness Scorecard

CRITERIA		Discovery	Feasibility	Practicality	Technology Readiness	Applicability	Production Readiness
1.	Consistency w/ strategies						
→ 2.	Technical Validity	◆	◆	△			
3.	Cost, Benefit, Risk	◆					
→ 4.	Competitive Technology	△					
5.	Scalability						
→ 6.	Collateral Impact	△					
7.	People/Organization Readiness						
→ 8.	Tech User Endorsement	△					
9.	Intellectual Property	◆					
10.	Technology Information						

◆ Complete  
△ In-Work



# Technical Validity

## Discovery

## Feasibility

## Practicality

Preliminary evidence suggests promise	90% sure it's going to work, from a multidisciplinary perspective	<b>Credible, documented scientific evidence exists that the technology is sound. Validation has been accomplished by analysis, experiment, test or computation as appropriate.</b>
Potential application identified (limits unknown, robustness unknown)	Specific potential application identified (limits emerging, preliminary robustness assessment)	<b>The technology meets the requirements for practical application. The limits of applicability are known, and the robustness (i.e.. sensitivity to variability) is understood.</b>
Approvability and standards issues identified	Approvability or standards conformance looks likely	<b>The technology is approvable by appropriate external agencies (e.g.: certifiable by government agencies, conforming to industry standards).</b>

# Competitive Technology

## Discovery

## Feasibility

## Practicality

The technology is potentially promising compared to known alternatives	Survey of alternative technologies indicates that this technology has definite advantages	<b>Potential alternative technologies for the same applications to our products and processes have been identified and compared with regard to benefit, cost, risk and readiness</b>
The technology is potentially promising compared to known alternatives	Competitive implications of the technology have been identified and assessed	<b>The technologies in development, in use by, and/or available to our competitors have been identified and compared, and the competitive implications are quantitatively understood</b>

# Collateral Impact

Discovery	Feasibility	Practicality
Identified key issues of collateral impact	Plan developed to address key issues Development plans for interdependent technologies are in place	<b>Impact of technology applications are identified, understood and acceptable for:</b> <ul style="list-style-type: none"><li>•Affected processes</li><li>•Affected disciplines, program organizations and people (see People and Organizational Readiness)</li><li>•Complementary technology</li><li>•Infrastructure for application</li><li>•Production readiness requirements</li></ul> <b>Interdependent technologies in other categories of deliverables are also technology ready in all aspects.</b>

# Technology User Endorsement

Discovery	Feasibility	Practicality
Potential users have been identified and may have been involved as appropriate	Representative internal and external users identified and involved in evaluation with the technology developer	<b>Potential Launch customer and the technology developer jointly concur that the application is technology ready and ready for first application implementation preparation</b>
The developer shows technology might address needs and issues of technology users Breadth of application has been scoped	Representative user(s) concur the technology will address needs and issues of technology users  Work-statement and schedule could support representative user(s) if successful and funded  Breadth of application has been evaluated	<b>Technology user(s) and the technology developer concur that the technology fulfills Customer and/or industry needs and buys in to the technology value</b>  <b>Potential technology implementation work statement, schedules, supplier engagement, production plans, certification plans, resource requirements, risk mitigation plans, have been developed and concurred with by technology user(s).</b>  <b>The technology has been developed in a manner that could support multiple applications.</b>

# Role Alignments??

				Transition Hurdle		Transition Hurdle			
Maturity Stage	Discovery	Feasibility	Practicality	Technology readiness	Applicability	Production readiness	Build it	Keep it current and Maintain it	
Definition of requirements	Awareness of a need	Understanding of key requirements	Detailed understanding of generic requirements		Detailed understanding of application-specific requirements				
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Universities??

NASA

FAA Tech Center

FAA lines of Business

Boeing R&D

Boeing PD

Platforms Including CAS

# Summary

## To implement new technologies:

- Consistent with an important strategy
- Better than alternatives
- Affordable and scaleable
- Collateral effects are manageable
- Users and customers want it

• *And, Oh by the way -  
It works*